WITH THE AUTHOR'S COMPLIMENTS

JNS

P.545

1.

THE PLAGUE PROPHYLACTIC

WHAT IT IS, HOW IT IS PREPARED, AND WHAT ITS USES ARE

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Being the substance of a lecture delivered under the auspices of the Bombay Sanitary Association, in the Hall of the Health Section of the Bombay Industrial and Agricultural Exhibition on the evening of 20th December 1904, by Lieutenant-Colonel W. B. Bannerman, M.D., B.SC., F.R.S.E., Indian Medical Service, Director, Plague Research Laboratory, Bombay.

Sir Lawrence Jenkins, KT., K.C.I.E., Chief Justice of Bombay, in the chair.

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The Plague Prophylactic; What it is, how it is prepared, and what its uses are.

The plague prophylactic is essentially a culture in broth of the plague bacillus, and contains dead plague germs and the poison which they secreted during life.

It has therefore nothing to do with "serum" though you will often hear it called "the plague serum". Serum you know is the liquid that exudes from a blood clot, and it is used in medicine for various purposes but these need not detain us tonight.

Our subject is the plague prophylactic and it may conveniently be called the "anti-plague vaccine" following the practice adopted among European scientists, who call inoculating fluids which are composed of bacteria or their products "vaccines". These scientists follow the lead of Pasteur, who out of admiration for Jenner who first used the products of disease as a means of gaining immunity, called all such derivatives "vaccines" even although they had nothing to do with "vacca" which is the Latin for the cow.

I have just used the word "immunity" and must spend a little time in explaining what that means. The dictionary defines it as the state of being "not liable to infection" and we are all familiar with the immunity produced by vaccination for small-pox. We are likewise familiar with the immunity produced by an attack of some infectious disease such as measles or typhoid; a person passing through an illness caused by an attack of such a disease is not as a rule liable to a second attack. He has become immune to that disease.

Immunity and the means by which it is acquired has formed the subject of research for many learned men for years past, and they are only beginning to perceive glimmerings of light, and the commencement of the evolution of order from a chaotic mass of facts discovered by the innumerable workers who have wrestled with this problem.

The exact mechanism by which immunity is brought about,—whether it be the phagocytic theory of Metchnikoff, or the humoral theory of Ehrlich; or what perhaps is most probable, a modicum of both,—need not detain us tonight. What we are concerned with is the fact that after one attack of plague, the state of the sufferer's body is so changed that he is not, as a rule, liable to a second attack.

The plague bacilli while growing in that person's body secrete a poison which produces the train of symptoms which we call plague.

The cells of the body are stirred up by the action of this poison to produce an antidote which neutralises the plague poison.

And these cells go on secreting this antidote in such abundance that when all the plague poison is neutralised there remains a balance in the blood to act as a destructive agent should fresh plague bacilli gain entrance.

The person has become immune to the disease through the production of antidote in his system, due to the stimulus supplied by the action of the plague poison.

Now if you have followed me thus far you will see that if we can get hold of this plague poison, without the presence of live bacilli we might be able to produce immunity in any person or animal, by injecting a sufficiency of it to stir up the cells of the body to produce the desired antidote.

We cannot inject live bacilli because it is impossible to control them when in the living body of a man or beast, but live bacilli are not necessary to the production of immunity, it is only their poisons that are needed for this purpose. If then some way could be found of keeping the bacilli in captivity, while making them secrete their poisons, and then destroying them while retaining their poison, the problem would be solved. The analogy of the honey bee may help to make the matter clear. These useful insects are kept in hives until they have secreted their honey; they are then got rid of and the honey becomes useful to man, which it could not be so long as the bee with his sting remained in evidence.

This then is exactly what we do at Parel. We catch our bacillary bee, we imprison him in a glass flask-hive, we allow him there to secrete his bacterial honey, and when he has made enough, we get rid of his inconvenient presence and take what he has produced for the use of the public.

Those of the public who are wise enough to allow themselves to be injected with these bacterial products are rendered immune by the reaction of their body cells to the plague poison, just as they would have been had they passed through an actual attack of plague.

But I must hasten on to explain how we make the prophylactic, having I trust made clear what the plague vaccine is and why we should take so much trouble to make it.

The first process is to obtain a suitable soil on which to nourish the plague bacillus.

In European laboratories this is done by soaking mince meat in water for 24 hours, expressing the juice, adding nutriment in the shape of peptone, and relish in the form of salt, and finally sterilising by heat.

This process was not however suitable for use in this country owing to the uncertainty surrounding the manufacture of commercial peptone. So it was resolved to make our own peptone. This was done by Colonel Warden, I. M. S., who was at the time Chemical Examiner in Calcutta.

The basis of our broth is minced goat's flesh mixed with pure hydrochloric acid. One kilo of the former mixed with 80 c. c. of the latter. This is kept at 70°C (158°F), in hot water in a jacketed tub for a week. The acid aided by the heat sets up a process of digestion, the albumen of the meat becomes converted into acid albumen, albumose and peptone.

The solid meat has been converted into a thick fluid mass, which is now diluted in the proportion of 3 litres of water to each kilo of meat in the original mixture, neutralised by the addition of caustic soda, filtered and placed for an hour in the large sterilizer to precipitate the coagulable albumens and phosphates, so that we may obtain a clear fluid afterwards. This is now filtered and re-sterilised in flasks carefully plugged with cotton-wool, and the broth is then ready for use. You will see that we have manufactured our own peptone, and likewise the necessary medicum of salt. This last is made by the action of the hydrochloric acid on the caustic soda and the proportion of these chemicals used is such that the fluid contains the ·5 per cent. necessary for the nutriment of the bacteria. Before the final sterilising a couple of drops of cocoanut oil are introduced into each flask for the bacilli to catch on to.

For those who object to meat products, a similar broth, containing the same albumenoids and peptone, is prepared from wheat flour. The wheat-derived broth is exactly similar in appearance and composition to that obtained from the goat's flesh.

A solid medium is likewise made by the addition of Agar Agar, a Chinese or Japanese seaweed, which many must be familiar with under the name of " Chini ghas ".

Having prepared the soil the next process is the procuring of the seed.

This is done by piercing the bubo of a recently dead plague patient, with a sharp glass pipette and sucking up a little of the fluid. This fluid contains countless plague germs, and these are at once transferred to flasks of broth.

These Pasteur flasks are peculiarly shaped and are used for sowing the larger stock flasks in which the bacilli are grown. Before the Pasteur flasks are used for sowing we must make quite certain that our seed material is pure and not mixed with the seed germs of any other disease.

This is done by observing the formation of stalactites which takes place when a pure culture of plague is allowed to grow in broth in a flask which is kept perfectly at rest for two or three days. You may see a diagram of these Haffkine's stalactites on the wall behind me, and as they are produced by plague germs only, and by no other germ as far as we know, this appearance forms a very convenient test for the purity of our plague growth.

The large flasks when sown are kept on shelves in the incubation room and the appearance of stalactites watched for; should any flasks show a different appearance they are at once rejected as unfit for use. The flasks are kept in the dark for six weeks or longer to allow of the growth of the plague bacilli and the formation of the precious plague poison without which no immunity could be obtained.

At the termination of this period a test is taken to see whether the growth in the flask is still plague and nothing but plague. This is done by withdrawing a few drops by means of a long pipette and sowing these on the surface of the Agar jelly. In a few days one can tell by looking at the resulting growth whether the material sown had contained plague and plague only. For just as the farmer can tell his crops while they are growing in the fields, so bacteriologists can distinguish the various kinds of bacteria by their appearance on Agar or other medium.

After this test is taken the flask is passed on to the sterilising tub where it is kept in hot water at 55°C (131°F) for 15 minutes. This suffices to kill all the germs.

Then carbolic acid is added in the proportion of $\frac{1}{200}$ of its bulk = 0·5 per cent. This addition of carbolic acid is a most important step in the manufacture for it practically makes the broth an unsuitable medium for the growth of any sort of germ and therefore ensures that no such disaster as that which took place at Mulkowal can ever again occur. The Government of India, on the 13th of December 1904, issued a communique on this subject in which they publicly state :—" The system of inoculation against plague with a fluid prepared from the sterilised virus of disease was introduced in India by Mr. Haffkine early in 1897. The composition of the fluid was subjected to searching enquiry by the Indian Plague Commission, who pronounced its employment to be free from danger, and it was used on a large scale in various parts of India without producing injurious effects. In September 1902 the standard method of manufacturing this fluid was changed by the Director of the Plague Institute on his own authority with the object of expediting the process and thus meeting the heavy demand then being made by the Punjab Government in connection with a large scheme of inoculation. The change involved the omission of a small proportion of carbolic acid which had up till then been added to the original fluid as a further precaution against contamination. The new fluid, or water-agar process, contained no carbolic acid, other methods being relied upon to ensure its purity.

On 6th November 1902, nineteen persons who had been inoculated on 30th October, in the village of Mulkowal from a single bottle (labelled 53-N.) of the new fluid, were found to be suffering from tetanus and all of them subsequently died.

A Commission consisting of Sir Lawrence Jenkins, Chief Justice of Bombay, Lieutenant-Colonel Bomford, Principal of the Medical

College, Calcutta, and Major Semple, Director of the Pasteur Institute, Kasauli, was appointed by the Government of India to enquire into the disaster. They found that the germ of tetanus had been introduced into the fluid before the bottle was opened at Mulkowal and they thought it probable that this might have occurred owing either to insufficient sterilisation, or to the process of filling the bottle from a larger flask having been performed with defective precautions.

They also expressed the opinion that carbolic was a valuable agent in restraining tetanus growth when added to the plague prophylactic and they, therefore, thought that its omission was a grave mistake.

Experiments undertaken in India by two independent inquirers appeared to confirm this view, and their conclusions, together with the data on which they were based, were submitted with the report of the Commission for examination and further experiment to the Lister Institute in London."

With regard to this point the authorities of the Institute report as follows :—

> " The Institute is in entire agreement with the Commission as to the value of 0·5 per cent. of carbolic acid in restraining tetanus growth, when added to plague prophylactic, and its experiments emphasize still further the importance of this addition in preventing growth and toxin formation in vaccine which might be liable to the possibility of contamination with spores of tetanus."

In other words then it appears that the cause of the Mulkowal disaster was the growth of tetanus in uncarbolised vaccine. The conclusion arrived at after experimentation by both the Commission and the Institute is, that tetanus cannot grow in vaccine containing 0·5 per cent. of carbolic acid, and that therefore the addition of this amount of the antiseptic is an efficient safeguard. Needless to say this amount is now always added to the vaccine. No one therefore need be afraid of getting tetanus, or any other disease should he submit to inoculation.

The next process is the bottling of the vaccine, and as this used to be freely criticised I trust you will be interested in seeing how this difficulty has been overcome.

The problem to be solved is, how to transfer the prophylactic from the large flask to the bottle without danger of contamination from the air or surrounding objects.

This is accomplished in the following way. A sterilised syphon is placed in the flasks in such a way that no germs can gain entrance.

This syphon is then, by means of an ingenious joint piece connected to a bulb likewise sterilised, which is closed by an India rubber diaphragm.

Inside the bulb is a curved metal breaker against which the point of the vacuumised bottle is thrust so as to break it off.

The broken point of the bottle falls to the bottom of the bulb, and the fluid in the bulb rushes in to fill the empty bottle.

You will observe that the point of the bottle during this time is inside the bulb and effectually protected from contact with the air, by the rubber diaphragm through which it is thrust.

The bottle itself is vacuumised by boiling a little water in it and thus expelling the air. Before the bottle can cool down again its tip is sealed by melting the glass. It is then packed as you see in an iron box holding fifty at one time, and sterilised for 3 hours in a hot air oven heated to 170°C (338°F). Before introducing the fine neck of the bottle into the bulb, by thrusting it through the rubber diaphragm which separates the vaccine fluid from the air, it is sterilised by means of the Bunsen burner.

There is therefore no chance of the bottle conveying contamination to the fluid, and as the neck is at once sealed off in a flame when it is withdrawn, the chances of any germ gaining access to the fluid at this stage are nil.

The bottles are now set aside for 10 days, to give time for any germ that might be there to grow, and then two bottles of the brew are opened and tested for sterility. This is done in two ways. You must know that there are two sorts of germs. One sort grows in atmospheric air, and these are called aerobic; and another kind called an-aerobic will only grow in an atmosphere from which oxygen is excluded. To this latter category belongs the germ of tetanus It is therefore necessary to test the fluid both with air present, and when oxygen is excluded. Should these tests prove satisfactory the brew is pronounced fit for use.

Then the last stage in the process is carried out. The bottles are jerked so as to fill the long necks full of fluid.

The neck is sealed off close to the bottle in such a way that the fluid in it is enclosed just as the vaccine in the bottle is. The neck therefore contains a sample of the fluid in the bottle and is kept in the laboratory as an " office copy ". Should any suspicion arise as to the condition of the contents of the bottle, we can refer to the sample contained in the neck, and test it.

The bottles are then packed in cylinders of corrugated paper, and sent out in boxes of 500 doses or so.

In concluding this part of the demonstration, I would draw your attention to the number of times the fluid is tested —

(1) As to the purity of the seed germ.

(2) As to the purity of the growth in the stock flasks at the beginning of the incubation.

(3) As to the purity of the growth at the end of the period of incubation.

(4) As to the sterility of the vaccine 10 days after bottling.

The whole process is so simplified and guarded by so many precautions that it is humanly speaking impossible for anything to go wrong. The medical man may, therefore, use this vaccine with perfect confidence that he will do his patient no harm.

The actual process of opening the bottle is also much improved. There is no cork to drop. The bottle cannot be opened by accident or from curiosity, without first sterilising the neck.

When once opened it cannot be closed again, and there is therefore no temptation to keep any of the fluid for another day.

The method of opening is simple. The stump of the neck is heated in a flame till it is sterilised. Then with a jerk the cold fluid in the bottle is made to impinge on the hot glass, which in consequence cracks off and the bottle is opened.

It may then be turned upside down, and the needle of the sterilised syringe introduced and filled.

The syringe itself is sterilised by means of oil heated to 160°C (320°F) and the needle between each operation is dipped into it and thus sterilised effectually.

Having learned how the prophylactic is made and administered, let us study the effects it can produce during plague epidemics.

Mr. Haffkine, its originator, first proved its efficacy in the latter part of 1896 by protecting rabbits against plague, and in January 1897 had himself inoculated by Dr. Surveyor of this city. At the end of the same month, the historic outbreak of plague in the Byculla jail afforded an opportunity for testing the efficacy of the fluid. The result was as follows :—

183 uninoculated persons	had	12	cases	with	6	deaths.
154 inoculated	,,	2		,,	0	,,

This result at once gave a great stimulus to inoculation, and the room in the Petit Laboratory where the prophylactic was made, became crowded with applicants eager to protect themselves against this new and terrible disease. Since then over 5¾ million doses (actual number =5,827,539) have been issued from the laboratory and many records of statistics have been prepared.

In the short time at my disposal I cannot do more than refer to a few of them, but I may say that all these statistics show that in all cases without exception there has resulted a very remarkable reduction in the number of cases of plague among the inoculated, and those who are attacked subsequently to inoculation recover in much greater proportion than the uninoculated.

Mr. Haffkine has formulated the results as follows :—

"During an epidemic there are about three times fewer attacks of plague in the inoculated; and among plague patients the number of deaths in those who have undergone inoculation, is about half as compared with the mortality amongst the uninoculated patients. The final result is that during the prevalence of plague, the number of deaths in the inoculated is about one-sixth that amongst the uninoculated living in the same infected locality."

The Indian Plague Commission arrived at the following conclusions, which you will see are in agreement with the above opinions. They say (Vol. V., p. 262) :—

> "1. Inoculation sensibly diminishes the incidence of plague attacks on the inoculated population, but the protection which is afforded against attacks is not absolute."

> "2. Inoculation diminishes the death-rate among the inoculated population. This is due not only to the fact that the rate of attack is diminished, but also to the fact that the fatality of attacks is diminished."

The first two examples I propose to lay before you to-night are chosen because the statistics regarding them were collected with great care, and the circumstances were such that a degree of accuracy approaching that of a laboratory experiment was attained.

The first experiment was undertaken at the request of the authorities of Baroda State, and with their assistance.

The village of Undhera, six miles from Baroda City, inhabited by agriculturists, was attacked by plague in the end of December 1897. According to a census taken by the Baroda authorities on the 5th of January 1898, there were 1,031 souls in the village. Between that date and 12th February, when the inoculations were performed, seventy-six persons died of plague, ten had left the village, and five were born, thus leaving 950 persons alive on the latter date. This mortality is equivalent to a death-rate of 766 *per mille per annum*, and will serve to show how virulent the epidemic was. On the 12th of February, Mr. Haffkine and I visited the village, accompanied by the Chief Plague officials of Baroda State, and some half dozen local medical men who had just been instructed in the art of inoculation. The witnesses of the experiment were therefore fairly numerous and representative. The village was divided into two halves, Mr. Haffkine operating in one section and I myself in the other. Our mode of operation was as follows :— We went from door to door, calling out the people by name by reference to the census paper. As each household was collected in the street, half of the members were inoculated, and half left untreated to serve as controls. An endeavour was made to divide equally the men, women and children in each household, and to have an equal number of sickly in the two groups. That the division effected was a fair one will be manifest from the following table, which shows the sex and age distribution of the inhabitants of the twenty-eight houses in which plague cases occurred after the inoculation. A subsequent examination also showed that there were, at the time of operation, more sickly individuals among those inoculated than in the uninoculated group, so that the balance was in favour of the latter in this repect :—

Ages.	Inoculated.			Not Inoculated.		
Five years and under ...	Males ...	4	13	Males	5	10
	Females ..	9		Females... ...	5	
Between 6 and 59 years inclusive.	Males ...	34	54	Males	18	51
	Females ...	20		Females... ...	33	
Sixty years and over ...	Males ...	3	4	Males	1	3
	Females...	1		Females... ...	2	
	Total ...		71	Total ...		64

No difficulty was experienced in inducing the people to be inoculated ; in fact, one had to refuse to go beyond the half in each family in spite of the protests of its members. When we summed up at the end of the day, it was found that we had inoculated 513 persons, or 76 more than the half. The village was then left in charge of a native medical man who had a small hospital within a hundred yards of the place. Six weeks after (4th April 1898), an investigation was made by the late Surgeon-General R. Harvey, M.D., C.B., Director-General of the Indian Medical Service, Mr. Haffkine, Captain Dyson, I. M. S., and myself, assisted by the local authorities of Baroda. Each house in which a plague case had occurred since the 12th of February was visited, and the occurrences among the members ascertained by personal inquiry from the survivors, by reference to the hospital register, and from the census papers, in which had been entered the doses of prophylactic administered. I myself carried the census lists, and from it called out the inhabitants of the plague-infected houses by name, and I shall never forget the experiences of that day. One incident I particularly remember—the finding in two huts in succession that all the uninoculated had died and that only the inoculated members of the household came out to answer to their names. The attitude of the people was also very striking, for, when asked about the results of the experiment, they said that "about fifty uninoculated had been attacked and they are all dead, while only a few inoculated have been ill, and they have all recovered." This turned out to be an example of oriental imagination, as the following will prove, but it serves to show the impression the operations had left on the minds of the villagers. That the neighbours were also favourably impressed was shown by the arrival of a deputation, requesting us to come next day to inoculate them, which we accordingly did, operating on 700 in three hours.

The following table is the result of this investigation. Plague continued in the village for forty-two days after the inoculations were performed, and affected twenty-eight families.

Among the Inoculated.

(*a*) There were no deaths from causes other than plague.

(*b*) There were no deaths during the first three days after inoculation, the first fatality being recorded on the 21st eight clear days after.

(*c*) From the 15th February till the end of the epidemic there were eight attacks of plague, of which three had a fatal termination.

Among the Uninoculated.

(*a*) A child aged one year died of bronchitis on 21st February 1898.

(*b*) Three died of plague during the first three days following the inoculation, and are therefore omitted from the calculations as having been attacked before the inoculations were carried out.

(*c*) From the 15th of February till the end of the epidemic, twenty-seven more attacks of plague occurred, of which twenty-six died.

One of the three fatal cases among the inoculated had no interval between the inoculation fever and the manifestation of plague; the two others had *a*-pyretic interval of six and eight days respectively.

The events in each of the twenty-eight families affected were noted on 'investigation sheets,' one for each household, in which the names of every member present at the time of inoculation were entered as either 'inoculated' or 'not inoculated.' The occurrences in each household being entered on each sheet below the names, it was then easy to compile the following table :—

Ward Number.	House Number.	Inoculated.			Not Inoculated.		
		Number Inoculated in the Family.	Number of Attacks.	Number of Deaths.	Number not Inoculated in the Family.	Number of Attacks.	Number of Deaths.
1	8	4	...	...	1	1	1
1	63	3	...	...	2	1	1
1	67	3	...	...	2	1	1
2	24	1	...	...	1	1	1
3	1	2	...	...	2	1	1
3	15	2	1	...	3	...	...
3	20	3	1	...	4	1	1
3	29	3	...	...	2	1	1
3	39	4	1	1	3	1	1
3	42	1	...	...	2	1	...
3	48	5	...	...	3	1	1
3	49	1	...	...	5	1	1
4	7	1	1	...	1	1	1
4	8	2	1	...	1	...	...
4	10	4	1	...	1	...	...
4	12	2	...	...	2	1	1
4	13	2	...	...	1	1	1
4	18	3	...	...	2	2	2
4	26	1	...	...	2	2	2
4	30	1	...	...	3	1	1
4	31	4	1	1	2	...	...
4	34	2	...	...	3	1	1
4	35	1	1	1	1	1	1
4	53	2	...	...	2	1	1
4	80	4	...	...	4	1	1
4	84	5	...	...	5	2	2
4	89	2	...	...	1	1	1
4	90	3	...	...	3	1	1
	Total ...	71	8	3	64	27	26

If one contrasts the fourth and fifth columns, which show the numbers of attacks and deaths among the inoculated, with the seventh and eighth, which set forth the same for the uninoculated, one gets a good idea of what would happen in a plague-stricken place if all the inhabitants were to be inoculated. For if the uninoculated half of the villagers had also been operated on—and there would not have been the slightest difficulty in doing this—the mortality among them would have been reduced 89·6 per cent. from what it actually was, or, in other words, they would have had ten times fewer deaths. For, if the inoculated had suffered to the same extent as their uninoculated relatives, they should have had 29 deaths from plague, instead of 3 only. The proportional number—29—is reduced by 26, which is equal to a diminution of 89·6 per cent. of mortality attributable to inoculation.

The report of this investigation, submitted to the Government of India by Surgeon-General Harvey, naturally produced a very great impression on the authorities, and induced them to encourage the introduction of this measure into all plague-infected places, and no one has been able to throw any sort of doubt on the accuracy of the figures. The Indian Plague Commission remark that they have scrutinised the investigation sheets, and find that the "proportions of the various ages and sexes were evenly distributed among the two classes. The correctness of Mr. Haffkine's figures is further confirmed, after making allowance for the deaths excluded by him from his calculations, by figures separately given to us by Major Bannerman and Mr. H. D. Mehta. The experiment at Undhera appears to us to be the most important experiment regarding the effect of anti-plague inoculations that has as yet been carried out. It derives its importance firstly from the fact that the inoculated and uninoculated persons under observation were fairly numerous, and that their numbers were determined with a considerable degree of accuracy; secondly, because the communities of the inoculated and the uninoculated were comparable, and lived under similar conditions; thirdly, because the communities were equally exposed for a period of six weeks to an outbreak of plague which carried off 6·2 per cent. of the uninoculated; and, lastly, because the results set down by the Native Hospital Assistant were checked in the manner described above.

The only point which seems calculated to arouse a doubt as to the trustworthiness of the results recorded is the fact that 27 out of 28 persons attacked are said to have died. This certainly is an astonishing mortality, and might be taken as indicating that the village records are seriously inaccurate. If, however, we assume—and, with the exception of Dr. Ruffer, who thinks the records cannot be accepted as accurate, we do make the assumption—that the checks applied on the spot were sufficient to ensure the detection of really gross errors, then we may deduce two lessons from the Undhera experiment. Firstly, we learn that the number of plague attacks among the uninoculated is much larger than that among the inoculated; in this particular case, as the table given above will show, plague attacks were proportionately four times more numerous among the uninoculated than among the inoculated. The second lesson we learn is that the percentage of deaths among the attacked is very much higher among the uninoculated than among the inoculated; in this particular case, as the table again shows, the percentage of deaths among the uninoculated was proportionately ten times as great as among the inoculated."*

The second example which I propose to give you is of more recent date, the outbreak having taken place in February 1900, in a 'chawl' (or barrack-like house) No. 201, Cattle Lines, Pilot Bunder, Colába, Bombay.

The chawl was a single-storey building containing ten rooms, arranged in two rows back-to-back, separated from one another by 7-foot partitions but having the roof space common to all. All these rooms communicated with one another by doors, with the exception of two at one end, which were self-contained, but did not, however, escape infection on that account. Three rooms did not furnish any cases, though some uninoculated persons were living in them. The inhabitants all belonged to a low caste of Hindus called Mángs, and would therefore mix freely with one another. The chawl was situated in a square close to the sea, and near it was another building inhabited by a set of Gaolis or milkmen, and a cowshed. When plague broke out among the Mángs, the Gaolis noticed that rats were dying in their quarter, and therefore wisely removed to the cowshed close by. They had no cases among them, though, with the exception of one family, they were not inoculated. Thus the isolated Máng community, numbering sixty-one persons, afforded a good opportunity for an exhaustive enquiry; and this was accordingly carried out by Dr. E. L. Hunt, one of the medical men sent out to Bombay by the Secretary of State for India for temporary plague duty, and acting at the time as Inspector of Inoculation, assisted by Dr. Arjani, Section Medical Officer of A Ward, acting under the direction of Mr. Haffkine himself.

Of the sixty-one inhabitants, fifty-seven were either seen personally by one or other of the above-named investigators, or, if they had died meanwhile, the papers relating to them were secured from the adjacent plague hospital where they had been treated. The remaining four were not seen personally, as they had left the locality, three having gone to Poona. and one, a professional beggar, having disappeared in the city of Bombay. Only one of these four had been inoculated, and none of them were attacked. With the exception of these four, about whom the statements of neighbours had to be accepted, it was possible to furnish documentary evidence for all, showing when and by whom the inoculations had been performed, the date, duration and termination of the illness, with all the hospital notes and charts, and the condition of the survivors in

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* Report of the Indian Plague Commission, Vol. V, p. 214.

July 1900, five months after the epidemic ceased. All this evidence was submitted to Government and published by them in full.* The account now given is a condensation of this report.

The first case of plague developed symptoms on the 1st of February 1900, on the 2nd of the same month seven were attacked, on the 3rd, six, and then one case occurred on each of the following dates, *viz.*, 4th, 5th, 7th, 9th, 10th, and 12th February. Altogether twenty attacks took place, with twelve deaths. The inoculations had been performed on various dates from 11th December 1899 to 29th January 1900. The single case among the inoculated was in the person of a female, inoculated on 18th December, and attacked on 9th February: she recovered.

The following table shows the distribution of the inoculated and uninoculated, room by room, and the occurrences in each group :—

Room No.	Number of Inmates and whether they were Inoculated.	Number of	
		Attacks.	Deaths.
1	*1 not inoculated*	...	...
	2 inoculated	...	...
2	*8 not inoculated*	*4*	*3*
	3 inoculated	...	...
3	*6 not inoculated*	*4*	*2*
	4 inoculated	1	...
4	*1 not inoculated*	*1*	*1*
	2 inoculated	...	...
5	*4 not inoculated*	*4*	*4*
	1 inoculated	...	...
6	*4 not inoculated*	*3*	*1*
	5 inoculated	...	...
7	*3 not inoculated*	*1*	...
	3 inoculated	...	...
8	*3 not inoculated*	...	...
	2 inoculated	...	...
9	*3 not inoculated*	*2*	*1*
	1 inoculated	...	...
10	*4 not inoculated*	...	...
	1 inoculated	...	...

Number of Individuals.	Attacks.	Deaths.	Case-incidence per cent.	Case-mortality per cent.
Inoculated, 24	1	...	4·16	......
Uninoculated, 37	19	12	51·35	53·15

In other words, inoculation saved 7 lives in this chawl.

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* No. 1269 of 1900 from the Director-in-Chief, Plague Research Laboratory, to the Secretary to Government, Plague Department, Bombay, 9th August 1900. Printed at the Government Central Press, 1900.

The inhabitants of the rooms numbered 1 and 10 which adjoined one another at one end, but did not communicate directly with any infected room, may be excluded from the above, as no cases of disease occurred among them. No cases occurred in room 8 either, but as it communicated with room number 3, in which five cases occurred, its occupants are included in the following calculations. In the eight rooms taken into account, there were living fifty-three persons, of whom thirty-two had not been inoculated, leaving twenty-one who had been thus operated on. Each room contained a mixed population of inoculated and uninoculated persons, and we find that—

The 32 not inoculated had 19 cases, with 12 deaths.

The 21 inoculated had 1 case, with no deaths.

If the inoculated had suffered to the same extent as those not inoculated, they should have had twelve cases with eight deaths, but they only had one case, which recovered. This is equal to a reduction of 91·7 per cent. in the attacks in favour of the inoculated.

The fact that twenty-one of the inhabitants were away at work all day, and only returned to the chawl to sleep at night, makes no difference between the two groups, for on enquiry it was found that no cases of plague had occurred in the various places where these people had worked. The infection undoubtedly was localised in the chawl, and no circumstance existed that in any way favoured the one group over the other. The following statement brings this out clearly :—

Of those going out to work during the day, 16 not inoculated had 10 cases.

Of those staying at home all day, 16 not inoculated had 9 cases.

Of those going out to work during the day, 5 inoculated had no cases.

Of those staying at home all day, 16 inoculated had 1 case.

The fact that the uninoculated persons were equally divided between those who stayed at home and those who worked outside, and that the two groups returned almost the same percentage of cases, indicates that the source of infection was common to both, and must therefore have been in the dwelling-house itself.

The age-distribution of the 53 inhabitants of the eight infected rooms was as follows :—

Up to 10 years of age.	11	not inoculated had	7 cases with	2 deaths.
	4	inoculated ,,	0 ,,	0 ,,
From 11 to 50 years of age.	20	not inoculated had	12 cases with	10 deaths.
	17	inoculated	1 ,,	0 ,,
Above 50 years of age.	1	not inoculated had	0 case with	0 death.
	0	inoculated ,,	0 ,,	0 ,,

From the above it will be seen that the fatalities occurred mainly among those between the ages of eleven and fifty years, and that, though the children show a number of attacks, yet they had a smaller death-rate.

The sex-distribution given below shows that the men were more susceptible than the women, but had greater power of recovery. All the women who were attacked died, except the one who had been inoculated.

Males ...	21 not inoculated had	14 cases with	7 deaths.
	6 inoculated	„ 0 „	0 „
Females .	11 not inoculated had	5 cases with	5 deaths.
	15 inoculated	„ 1 „	0 „

The above particulars, carefully got together by painstaking enquiry, prove

(*a*) That the infection was localised in the chawl.

(*b*) That all the inhabitants were living under precisely the same conditions, with the single exception that some were inoculated and others not.

(*c*) That the lessened incidence of plague in the inoculated was due solely to the effect of the material injected.

These two demonstrations, which are accurate to a high degree, prove unquestionably the two propositions formulated above, and which may be again restated with the added weight of the words of the Indian Plague Commission (Vol. V, p. 262) :—

" 1. Inoculation sensibly diminishes the incidence of plague attacks on the inoculated population, but the protection which is afforded against attacks is not absolute."

" 2. Inoculation diminishes the death-rate among the inoculated population. This is due not only to the fact that the rate of attack is diminished, but also to the fact that the fatality of attacks is diminished."

The next examples I propose to give you are extracted from the report of the Municipal Commissioner on the Plague in Bombay for the year ending 31st May 1900, and will be personally interesting to my audience on that account.

After relating briefly the facts of the Colába Chawl related above, the report shows how the Marine Battalion 775 in number had all been inoculated except 75, when plague broke out. " Six cases occurred and of these 3 were among the uninoculated, and 3 among the inoculated. The percentage of attacks among the uninoculated was therefore 4·00 ; among the inoculated 0·42."

" Thanks chifly to the enthusiasm and energy of Mr. N. N. Gazdar, a great number of the inhabitants of Frere Road and adjoining streets were inoculated. The densely crowded chawls of this locality suffered severely from plague in past years, but escaped comparatively lightly during the year under report, and the district officer is unable to assign any reason for this, except inoculation.

From several examples of the good effects of inoculation in B Ward, the case of house No. 31—33 Jail Road (North) may be selected. It is a dirty insanitary building inhabited by Mhárs. It had a bad plague record for 1898, and between 1st May 1899 and 30th December 1899 there were 22 deaths there, of which 4 were plague and 7 suspicious. The majority of the inmates were inoculated on the latter date. Between 5th January 1900 and 28th May 1900, 42 deaths occurred in the house, of which 7 were plague and 9 suspicious. Not one of these deaths occurred among the inoculated, though the locality was a perfect hot-bed of plague.

In C Ward among not a few others, Patakwadi and Tara Naikin's Wadi may be cited as good instances of the value of the prophylactic. In house No. 44 Patakwadi, a highly infected locality, where in the previous epidemic every house had to be vacated more than once, all the people—60 in number—were inoculated during the year under report, except one old woman, who was in too debilitated a condition, and a barber who persistently refused to undergo the operation. No cases of plague were observed here this year, except one which was brought into the house from another ward, and the case of the uninoculated barber mentioned above.

In Tara Naikin's Wadi, the manager of a large chawl was instrumental in getting about 500 of the inmates inoculated—of these only one died of plague some 40 days later. About 500 others, living in the same Wadi under similar conditions, refused to accept inoculation, and among them there were some 20 deaths from plague" (pp. 78 and 79).

In Kumbharwada Lieutenant Browne and Dr. Cama, with the help of some volunteers, did a large number of inoculations. The following table summarises the results in houses where they succeeded in pushing inoculation. "The results speak for themselves" (page 79):—

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Name of house.	Inoculated.		Uninoculated.		Remarks.
	Number inoculated.	Number of Deaths.	Number not inoculated.	Number of Deaths.	
146—150 Duncan Road	85	...	75	3	
149—151 Bhandari Street ...	35	...	47	7	
173 Bhandari Street	71	...	59	*3	* 2 more cases, result not known.
331—336 Duncan Road	36	1	34	5	
Patras Chawl, Pathan Street ...	170	...	180	*7	* 3 more cases, result not known.
304—306 Duncan Road	75	...	79	*7	* 1 more case, result not known.
16—18—20 Carpenter Street ...	36	...	84	4	
16 Kumbharwada	64	...	86	3	
169—181 Kumbharwada ...	59	...	34	*4	* 2 more cases, result not known.
6 Bhandari Cross Lane ...	12	...	3	1	
185 Kumbharwada	55	...	70	2	
236—238 Kumbharwada ...	59	...	21	*4	* 1 more case, result not known.
57—59 Northbrook Street ..	45	...	25	*3	* 3 more cases, result not known.
49 Northbrook Street	10	2	15	1	
45 Northbrook Street	47	...	13	*3	* 1 more case, result not known.
88—92 Northbrook Street ...	53	...	97	1	
151 Falkland Road	69	...	7	4	
124 Northbrook Street	47	...	33	*3	* 2 more cases, result not known.
246 Kumbharwada	36	...	9	*2	* 2 more cases, result not known.
Total ...	1,064	3	971	67	

Population.	Deaths.	Mortality percentage on population.
Inoculated, 1,064	3	0·28
Not inoculated, 971	67	6·8

"In house No. 7—8 Pirkhan Lane (E Ward, West), out of 500 people, some 300 were inoculated. Among the 300 inoculated there were 2 cases of plague: among the 200 uninoculated 15 cases.

In house No. 26, of about 100 inmates, some 50 were inoculated. Among these 50 there was one case of plague only: among the 50 uninoculated there were 6. The sectional Medical Officer states that in a total population of 9,000 people in 1st Nágpáda, there were 428 cases of plague, and of these all but 8 occurred amongst the non-inoculated while the proportion of inoculated to non-inoculated may be roughly stated as 1 to 13.

Turning to E Ward, Wári Bunder, in Anjirwádi, inoculation was pushed with considerable success, and the greater part of the inmates, numbering in all about 1,000, were inoculated. Among the few who were not inoculated 13 cases of plague occurred. Among the large number inoculated only one suspicious case. In house No. 3 Mazawarpakhadi, containing between 20 and 30 inmates, all but 2 were inoculated. One was away, and the other said she could not be inoculated as she had to cook. Both of these succumbed to plague, but the inoculated people remained immune. In house No. 6 Mazagon Road, of some 500 residents, 200 were inoculated. Of the 300 uninoculated, 18 were attacked, but not one of the 200 inoculated. In Hyderali Chawls, out of 300 people, 100 were inoculated. Among the 100 inoculated two got plague: among the 200 uninoculated 21. In house No. 3 Albert Road, of 60 residents 35 were inoculated. Plague attacked the house with considerable virulence and 10 cases occurred. These were all among the uninoculated" (pp. 79—83).

There are more such statistics in the Municipal Commissioner's report, but for brevity's sake the above must suffice, and they are surely sufficiently convincing.

Last year in the Punjab a very extensive inoculation campaign was carried out, and the following table has been prepared from the report submitted by Major E. Wilkinson, I. M. S., the Chief Plague Medical Officer.

PUNJAB, 1902-03.

Statistics from all villages where 10 per cent. or more of the inhabitants had been inoculated, and where plague was present, or subsequently appeared, not later than 4 months afterwards :—

Population.	Attacks.	Deaths.	Case-incidence per cent.	Case-mortality per cent.
Inoculated, 186,797 ...	3,399	814	1·8	23·9
Not inoculated, 639,630 ...	49,433	29,723	7·7	60·1

In other words, inoculation saved some 8,000 lives in these villages in the Punjab.

Major Browning Smith, I. M. S., wrote an extremely able and interesting report on the plague as he saw it in the Amritsar District of the Punjab of which he was in charge last year.

The following table is compiled from information contained in it:—

AMRITSAR DISTRICT, PUNJAB.

Major Browning Smith's Report, 1903.

Incidence of Plague in families, some members of which were inoculated.

Number of individuals in the families.	Attacks.	Deaths.	Case-incidence per cent.	Case-mortality per cent.
Inoculated, 303	31	...	10·2	......
Not inoculated, 229	161	131	70·3	81·3

In other words, inoculation saved 173 lives in these families.

Results obtained in the laboratory, where the experimenter has full control over the conditions under which experiments are made, strikingly confirm the statistics obtained in plague-stricken human communities, and prove their reliability.

Two further questions now arise, *viz.* :—

(*a*) Is the plauge vaccine harmful when applied to those in the incubation stage of the disease ? and

(*b*) When does protection begin to be effective, and how long does it last ?

As regards the first of these queries, we find Calmette asserting, before the International Congress of Hygiene and Demography at Paris, in September 1900, that " a person in the period of incubation for a slight attack of plague woud find the disease considerably aggravated if he submitted during this period to a preventive inoculation of Haffkine's vaccine. The case would almost certainly end fatally."* Some months later the same scientist emphasises this expression of opinion in the Harben lecture † delivered by him in London, and condemns the practice of inoculating with Haffkine's fluid those who have been in contact with a plague case. These opinions he founds on laboratory experiments only, never having had an opportunity to use the plague vaccine during an epidemic among human beings. It is well known, however, that the immediate effect produced by the action of a microbial virus varies with each species of animal operated on, and that quite as various degrees of immunity are produced in them by this means, so that it is impossible without trial to predict what the exact action on any fresh species may be. We must take experiments on animals as an indication merely of what may in the main be expected if the same procedure be applied to man, and it is quite legitimate, therefore, to set aside this dictum of Calmette's if we find from the examination of a sufficient mass of evidence derived from human beings that there is no harm apparent to those inoculated during the incubation stage of plague.

Inoculations have been carried out on a large scale in various parts of India, hundreds of thousands of persons (over 200,000 in Bombay city alone) having been operated on during the last four years. From the reports sent in from certain prisons and small villages, where accurate statistics have been kept, it has been found possible to compile the following table showing the case-mortality in persons inoculated during the incubation period of plague. These figures include all instances known to us in India up to 1901, where statistics have been kept with sufficient accuracy to admit of the extraction of this information.‡

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* Abstract in *Brit. Med. Journal* of 27th October 1900.

† *Brit. Med. Journal*, 24th November 1900.

‡ For full table, showing separately for each place the results obtained, *vide Brit. Med. Journal* of 14th September 1901.

	Attacks.	Deaths.	Case-mortality per cent.
Cases which had plague actually evident at time of inoculation, or which developed it the same day...	43	21	48·8
Cases which developed plague on 1st day after inoculation	40	23	57·5
„ „ 2nd day ...	40	22	55·0
„ „ 3rd „ ...	38	21	55·3
„ „ 4th „ ...	27	10	37·0
„ „ 5th „ ...	37	18	48·6
„ „ 6th „ ...	26	10	38·5
„ „ 7th „ ...	29	14	48·3
„ „ 8th „ ...	24	9	37·5
„ „ 9th „ ...	24	15	62·5
„ „ 10th „ ...	30	9	30·0
Total within the first ten days after inoculation ...	358	172	48·04
Cases which developed plague subsequently ...	566	230	40·6
Total plague cases among the inoculated ...	924	402	43·5
Total plague cases among the uninoculated portion of the population during the same epidemics ...	5,079	3,726	73·3

We have here records of over 6,000 attacks of plauge, with a case-mortality in the inoculated of 43·5 per cent., and in the uninoculated of 73·3 per cent. If Calmette's contention were correct, we should see a case-mortality of over 73·3 per cent. among those who were inoculated either with the plague symptoms already manifest, or who developed plague within the next few days. But what, on the contrary, do we find? According to the table, we see that on no occasion does the case-mortality even approach to such a figure; even those inoculated with the disease already manifest hava a case-mortality of 48·8 per cent. only, instead of 73·3 per cent.

It appears that in these statistics we have a sufficiently large body of trustworthy evidence to enable us to set aside Calmette's warnings—founded as they are on laboratory experiments on animals only—and to encourage us to inoculate all persons during a plague epidemic, whether they have been exposed to infection or not. One is further encouraged in this by the opinion of almost all those who have had practical experience of the measure—and in this number I include myself;—for instance, Dr. Alice M. Corthorn, M.B., London, who with her own hand performed some 32,000 inoculations in the towns of Dhárwár and Gadag, says :[*] "I think that these and the Dhárwár figures prove that, so far from its being inadvisable to at once inoculate the contacts of a case of plague lest they be incubating the disease, *it is desirable at once to inoculate all who have been exposed to infection.*"

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[*] Report on Anti-plague Inoculation Work in the Dhárwár District, by Alice M. Corthorn, M.B., B.Sc., Medical Officer on Plague Duty, Bombay. Government Central Press, 1899.

Again, in a report on plague at Sydney, Australia, Dr. Ashburton Thompson, the Chief Medical Officer of the Government, and President of the Board of Health, reports:[*] "Among the inoculated public, thirteen were attacked, ... all these patients not merely recovered, but had conspicuously light attacks. The cases occurred almost entirely among the earlier 200, while the virulence of the infection was at its highest" (page 12). "It will be noticed that attacks which occurred at, or before the lapse of about ten days from, inoculation were not aggravated by it" (page 13). It may be stated that of the thirteen cases noted by Dr. Thompson, eleven occurred within periods varying from the actual day of inoculation to the seventh day after the operation. Although I have not been able to find that the Indian Plague Commission considered this actual point, yet they incidentally remark,[†] when considering how soon protecton is acquired, that "the case-mortality of the first three days compares favourably with that of uninoculated patients," and in another place recommend "the encouragement of inoculation among persons left in the houses with the sick,"[‡] thereby certainly implying that there could be no risk in such a procedure.

We may then confidently say that the plague vaccine is harmless to those incubating the disease.

With regard to the first portion of the second of the queries noted above, an answer is at once furnished by the table. For it is evident that a measure which reduces the mortality in a plague-stricken community from an average of 73·3 per cent. to 57·3 in those developing plague the very day after inoculation, is one which acts with astonishing rapidity. On this point Haffkine, in his evidence before the Indian Plague Commission, says:[§] "The time necessary for the plague prophylactic to produce a useful effect is shorter than in any preventive treatment known, this period being in the anti-cholera inoculation four days, in vaccination against small-pox seven days, in the inoculation against anthrax twelve days, in the inoculation against rabies fifteen days, and in the present treatment apparently less than twenty-four hours." In the case of Undhera village already given, the number of attacks among the inoculated at once became less than among those not so operated on. As the villagers were divided into two groups as evenly as possible, there is no reason to suppose that there could have been fewer persons in the incubation stage of plague among those inoculated than among their uninoculated relatives. Why, then, did they have but two cases in the first week instead of eleven, which is the number they ought to have had if they had suffered in the same proportion as the uninoculated? The answer plainly is, that the inoculation had aborted the disease in these cases.

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[*] Report on an outbreak of Plague at Sydney, 1900, by the Chief Medical Officer of the Government, and President of the Board of Health. Sydney, William Applegate Gullick, Government Printer, 1900.

[†] *Report of the Indian Plague Commission*, vol. v., p. 258.

[‡] *Ibid.*, p. 338.

[§] *Ibid*, vol. i., p. 6, para. 47.

Further, if we study the figures in the last column of the table, we see that there is really very little difference from day to day in the effect produced during the first ten days after inoculation, although there is a steady increase of effect observable as time goes on. Up to the ten-day limit the case-mortality is 48·04 per cent., while after this period it is 40·6 per cent. These daily variations, and the comparatively small difference in the rates between the beginning and the end of the ten-day period, seem to point to a sudden very considerable measure of protection being secured after the lapse of twenty-four hours only. The reply to the first part of the query is therefore:—Protection begins to be effective after the lapse of twenty-four hours, and goes on slowly and steadily increasing for some considerable number of days thereafter. It is proper, however, to point out that the Indian Plague Commission, from a consideration of the case-mortality figures at their disposal—which were, however, some three times less than the 924 cases which I have been able to collect—arrived at the conclusion that "Inoculation does not appear to confer any great degree of protection within the first few days after the inoculation has been performed."* Nevertheless, we have seen that in the case of Undhera this degree of protection was sufficient to at once differentiate the group of inoculated from their unprotected relatives.

The last point to be decided is—How long does the protection last? To this, time alone can furnish a complete answer. If, five years after Jenner made his immortal discovery, he had been asked—How long does the protection conferred by vaccination last? he would probably have given it as his opinion that it was lifelong. Time has proved it otherwise, however, and one would be rash to predict what it may evolve in the case of plague inoculation. The Indian Plague Commission are of opinion that "Inoculation confers a protection which certainly lasts for some considerable number of weeks. It is possible that the protection lasts for a number of months. The maximum duration of protection can only be determined by further observation."† Mr. Haffkine, in his "Discourse on Preventive Inoculation," delivered at the Royal Society of London on 8th June 1899,‡ says: "As to the duration of the effect of the plague inoculation, the statement which can be made for the present is that it lasts at least for the length of one epidemic, which, on the average, extends from over four to six months of the year."

From the report published by the Parsi Panchayet last year, which gives the number of deaths among that community for 5 years and the causes of death in the inoculated and uninoculated, it would appear that the degree of protection remaining during the second year after inoculation, is only slightly less than that of the first year, and that even after five years some trace of protection remains.

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* *Report of the Indian Plague Commission*, vol. v., p. 262.

† *Ibid.* ‡ *Lancet*, 24th June 1899.

This result, arrived at after a most searching investigation, is most encouraging, and serves as an additional inducement to be inoculated.

The final conclusion then appears to be, that in this discovery of Haffkine's we have within our reach a means of controlling an epidemic of plague and converting it into a manifestation of sporadic cases only, easily controlled and exciting little alarm.

Conclusion.

Having now, as I hope, made myself sufficiently clear regarding the harmlessness and efficacy of the prophylactic, the questions arise—

How can any one refuse to accept it?

What is the secret of the resistance to inoculation?

The first point to notice in trying to answer these questions is that the number of medical men practically acquainted with inoculation, who do not believe in its protective power, is so small as to be in effect non-existent.

The second point appears to be the existence of a large amount of ignorance as to the effects produced, due mainly to the hindrance to the spread of knowledge imposed by the want of education among the masses of this country.

The third point may be found in the existence of a body of cranks,—of which however India cannot claim the exclusive possession—who appear incapable of weighing evidence, and who cannot distinguish between small evils and great ones. To them a sore arm and a little fever seems as important an evil as plague itself.

Fourthly perhaps the vague rumours of evils such as leprosy and loss of vigour reported to follow on inoculation may deter some, in spite of the fact that a careful Governmental enquiry conducted in the Southern Mahrátta Country failed to find any grounds in reality for such allegations.

But, gentlemen, when you review seriously the situation, can you avoid the conclusion that no measure yet adopted,—except evacuation which is not applicable to a large city like Bombay—has had any demonstrable effect on plague.

The people who pin their faith to disinfection cannot produce any figures to be compared to those on the wall behind me. They have to content themselves with comparing one year's epidemic with its predecessors; than which I know of nothing more fallacious.

These remarks however do not apply to disinfection of clothing which has some evidence in its favour. But that as Kipling says "is another story."

What I want to impress upon you is that sanitation has up to now been powerless to arrest plague even when presided over by so able a Health Officer as Dr. Turner. He cannot accomplish the impossible. Neither can a body like the Bombay Improvement Trust do much to stamp out plague for many years to come.

If any of my audience are alive 50 years hence they may see the fruits of the labours of Dr. Turner and the Improvement Trust when people have been taught the elements of hygiene and have proper houses to live in; but immediate results are in my opinion not to be looked for. If these opinions are correct, the only thing we can do *now* is to adopt inoculation on a large scale.

It is upon the leaders of the Native community that the responsibility rests.

It is impossible for Government or its officers to influence the people to any extent without their help; but with their help I feel sure we could grapple with plague, confident that the results of our labours would be the reduction of the next epidemic to small dimensions easily dealt with by Dr. Turner and his able assistants.

I need not say that anything I can do by means of giving lectures and demonstrations I am willing and glad to do, but the stimulus must come from you, the leaders of the Native community.

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